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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Application of : **KARNIN, et al.**

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Serial No.: 09/917,837 : Group Art Unit: 2631

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Filed : July 31, 2001 : Examiner: Freshteh N. Aghdam

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For : CDMA MULTI-USER DETECTION WITH A REAL SYMBOL  
CONSTELLATION

Honorable Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

**DECLARATION UNDER 37 CFR 1.131**

Sir:

We, the undersigned, Ehud Karnin, Shay Ben-David and Jacob Sheinvald, hereby declare as follows:

1) We are the Applicants in the patent application identified above, and are co-inventors of the subject matter described and claimed in claims 1-26 therein.

2) Prior to November 13, 2000, we conceived our invention, as described and claimed in the subject application, in Israel, a WTO country. Conception of the invention is evidenced by a paper we wrote in June, 2000, entitled "Improving CDMA Multi-user Detection by Constraining the Soft Decisions." The first page of this paper is attached hereto as Appendix A. The paper was

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submitted in its entirety as U.S. Provisional Patent Application 60/254,147 on December 8, 2000.

3) Prior to November 13, 2000, we met with Dr. Daniel Kligler, of Sanford T. Colb & Co., who was retained by IBM as outside counsel for the purpose of preparing the present patent application. We were informed that Dr. Kligler had a substantial backlog of new applications that he was preparing for IBM, and that there would consequently be a delay of approximately two months in drafting this application.

4) Because of the expected delay in preparation of the regular patent application, we submitted a request to Adv. Tal Noy-Cohen, IP Advisor in the IBM Haifa Research Laboratory to file our paper as a provisional application. We received approval for provisional filing on or about December 1, 2000.

5) On December 5, 2000, the provisional application was sent by courier to the United States, and on December 8, 2000, it was filed in the USPTO.

6) The provisional application gives a complete and detailed explanation of our invention, as claimed in claims 1-26 of the present patent application.

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and conjecture are thought to be true; and further that these statements were made with the

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knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.

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## APPENDIX A



# Improving CDMA Multi-user Detection by Constraining the Soft Decisions

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Written: June 2000

### Abstract

We introduce new DS-CDMA multiuser detectors that are specialized for the case where the bit-modulation is BPSK and the signature-waveforms are complex-valued. A typical example where complex-valued signatures naturally arise is the case where different real-valued code-streams are simultaneously applied to the I and Q branches at the transmitter. Another example is the case of multiple receiving antennas. Unlike the general-purpose decorrelating detector which first creates a complex-valued soft-decision and then makes the hard-decision by selecting the nearest alphabet member, our approach here is to exploit the fact that the alphabet is *real*, and therefore *a-priori* constrain the soft-decision to be real. Such a constraint cuts the number of unknown parameters by half (since each complex-valued soft-decision contains 2 such real parameters), resulting not only in a substantially better detection performance, but also in doubling the number of users that can be detected, as well as in lower computational-cost. Based on the constrained statistical model, we also introduce a decorrelating decision-feedback detection algorithm that further improves the detection performance. Simulation results confirming the theoretical results are included.

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